5. Total Maximum Daily Load(s)

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation are completed the result is a TMDL, which must equal the load capacity.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. The load capacity must be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for “other appropriate measures” to be used when necessary. These “other measures” must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow “gross allotment” as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 In-stream Water Quality Targets

The goal of the TMDL is to restore "full support of designated beneficial uses" on all 303(d) listed streams within the Beaver-Camas Subbasin. Water quality pollutants of concern for which a TMDL will be written are sediment and temperature. A TMDL will not be written for streams listed with flow alteration (natural and anthropogenic) as a pollutant since the EPA does not believe that flow (or lack of flow) is a pollutant as defined by CWA Section 502(6). The objective of this TMDL is to establish a declining trend in pollutant loading and to regularly monitor the pollutant load and beneficial use support. Pollutant reductions may be attained, in part, by improving canopy cover, vegetative buffers, and decreasing stream width/depth ratios along streambanks.

For temperature TMDLs a potential natural vegetation (PNV) approach will be utilized. It is assumed that shade is maximized and solar loading is minimized to a stream under PNV. Thus stream temperatures are at their lowest levels under PNV. The PNV approach is described below. Additionally, the procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in this section.

Potential Natural Vegetation for Temperature TMDLs

There are a several important contributors of heat to a stream including ground water temperature, air temperature and direct solar radiation. Of these, direct solar radiation is the source of heat that is easiest to control or manipulate. The parameter that affects or controls the amount of solar radiation hitting a stream throughout its length is shade. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Again, the amount of shade provided by objects other than vegetation is not easy to control or manipulate. This leaves vegetation as the most likely source of change in solar radiation hitting a stream.

Depending on how much vertical elevation also surrounds the stream, vegetation further away from the riparian corridor can provide shade. However, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. We can measure the amount of shade that a stream enjoys in a number of ways. Effective shade, that shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect. In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream, and can be measured using a densiometer, or estimated visually either on site or on aerial photography. All of these methods tell us information about how much the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation (PNV) along a stream is that intact riparian plant community that has grown to its fullest extent and has not been disturbed or reduced in anyway. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides the most shade and the least achievable solar loading to the stream. Anything less than PNV is allowing the stream to heat up from excess solar inputs. We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what can be done to decrease solar gain.

Existing shade or cover will be estimated for entire lengths of streams from visual observations of aerial photos. These estimates can be field verified by measuring shade with solar pathfinders or cover with densiometers at randomly or systematically located points along the stream (see below for methodology). PNV will be determined from existing shade curves developed for similar vegetation communities. A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. Existing and PNV shade can be converted to solar load from data collected on flat plate collectors at the nearest weather station collecting these data. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards. Existing shade cannot be greater than PNV shade, thus existing loads cannot be less than PNV loads. PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are considered to be the lowest achievable temperatures (so long as there are no point sources or any other anthropogenic sources of heat in the watershed).

Pathfinder Methodology

The solar pathfinder is a device that allows one to trace the outline of shade producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the spot that the tracing is made. At each sampling location the solar pathfinder was placed in the middle of the stream about one foot above the water. We followed the manufacturer's instructions (orient to true south and level) for taking traces. Systematic sampling was easiest to accomplish and still not bias the location of sampling. We started at a unique location such as 100 m from a bridge or fence line and then proceeded upstream or downstream stopping to take additional traces at fixed intervals (e.g. every 100m, every half-mile, every degree change on a GPS, every 0.5 mile change on an odometer, etc.).

Aerial Photo Interpretation

Canopy coverage estimates are provided for natural breaks in vegetation density, marked out on a 1:100K hydrography. Each interval was assigned a single value representing the bottom of a 10% canopy coverage class as described below (*adapted from the CWE process, IDL, 2000*):

Cover class	Typical vegetation type
0 = 0 – 9% cover	agricultural (ag) land, denuded areas
10 = 10 –19%	ag land, meadows, open areas, clearcuts

20 = 20 – 29%	ag land, meadows, open areas, clearcuts
30 = 30 – 39%	ag land, meadows, open areas, clearcuts
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested
80 = 80 – 89%	forested
90 = 90 –100%	forested

The visual estimates of cover were field verified with a solar pathfinder. The pathfinder measures effective shade and it is also takes into consideration other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, man-made structures). The estimate of cover made visually from an aerial photo does not take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that cover and shade measurements taken by densiometers and pathfinders, respectively are remarkably similar (OWEB, no date).

Aerial photo estimates likely underestimate spots that have higher cover and overestimate spots that have lower cover, when looking at the entire stream, these discrepancies balance themselves out. (Shumar 2005)

Design Conditions

Sediment

To quantify the seasonal and annual variability and critical timing of sediment loading, climate and hydrology must be considered. This sediment analysis characterizes sediment loads using average annual rates determined from empirical characteristics that developed over time within the influence of peak and base flow conditions. Annual erosion and sediment delivery are functions of a climate where wet water years typically produce the highest sediment loads. Additionally, the annual average sediment load is not distributed equally throughout the year. Erosion typically occurs during a few critical months.

Temperature

Solar loading from direct solar radiation leads to warming of stream temperatures; channel geometry and near stream land cover influence solar loading. Related facts about solar loading and stream temperature include the following:

- Stream widening and limited riparian shading will ultimately result in increased stream temperatures.
- There is a high degree of seasonality to solar heating; as ambient air temperatures increase in the spring and summer, the need to limit solar loading also increases.

- Canopy shading maintains cooler air temperatures in and around the stream and limits the quantity of direct sunlight to the water during the summer months when radiant energy is at its greatest.
- Solar loading is tabulated and analyzed during the warmer months (April-September) of the year, since this is the critical time period for beneficial use support (CWAL and SS) and the time when the most significant solar loading to the stream is expected to occur.

The temperature critical time periods for salmonid spawning in the Beaver-Camas Subbasin are identified as May 1st through June 30th (Schrader 2003) for spring spawners; and September 15th through November 15th for fall spawners.

Likely vegetative species identified for the established expected effective ranges are generalizations based on Bitter Restoration's *Classification and Management of USDI Bureau of Land Management's Riparian and Wetland Sites in Eastern and Southern Idaho* (Hansen and Hall 2002).

Beaver Creek

Beaver Creek flows from north to south with headwaters originating near the Montana border, at the continental divide, and ending at the confluence with Camas Creek. Beaver Creek is the second largest tributary in the subbasin. Geologically, upper Beaver Creek is dominated by alluvium with deposits of felsic pyroclast and conglomerate. The lower half of Beaver Creek, below Spencer, is dominated by mafic volcanic flow. The stream is dominated by alluvial valley stream reaches in the upper half and volcanic basalt canyons in the lower half.

Dominant natural vegetation on Beaver Creek above 5800 feet is likely to be bebb willow (*Salix bebbiana*), and geyer willow (*Salix geyeriana*). Below 5800 feet, dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)* are the dominant vegetation types.

Camas Creek

The headwaters for Camas Creek are where, West Camas Creek, East Camas Creek, Spring Creek, and Crooked Creek converge, near Eighteemile. The drainage from source tributaries is voluminous, with a spring peak just following snowmelt. During the peak flow period, flow is continuous from headwaters to Mud Lake. However, following peak flow, Camas is considered a loosing reach and flows naturally subside. Considerable dewatering for agricultural purposes also contribute to the dewatering of Camas Creek. Hydrologically, Camas Creek is an intermittent stream with limited connectivity to Mud Lake.

Physically, Camas Creek from headwaters to mouth, is dominated by a mafic volcanic flow lithology. The stream channel, where perennial flows exist, is characterized by a system of basalt canyon/basalt streambed transport reaches alternated by substrate dominated depositional reaches. The sediment dominated depositional reaches are the most susceptible to streambank erosion due to the moderately sloped stream channel and a lack of natural bank armoring provided by the natural basalt lithology. Annual sediment delivery was calculated based on streambank erosion in the susceptible substrate dominated reaches of the stream.

Natural vegetation on upper Camas Creek, 5600-6300 ft in elevation, is likely dominated by bebb willow (*Salix bebbiana*), and geyer willow (*Salix geyeriana*) and natural vegetation below 5600 feet, on middle Camas Creek, is dominated by bebb willow (*Salix bebbiana*) and coyote willow (*Salix exigua).*

Dairy Creek

Dairy Creek is a small tributary of Beaver Creek that flows from east to west. The lithology of Dairy Creek is a combination of alluvium in the upper reaches and conglomerate in the lower reaches. Generally, soils in the Dairy Creek watershed are gravely loam, deep and very well drained.

Upper Dairy Creek is forested and natural vegetation types are douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta).* Below the forested area, approximately 6500 feet, bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*) dominate.

Modoc Creek

Modoc Creek, originates in the northwestern corner of the watershed, headwaters for Modoc Creek are West, Middle, and East Modoc Creek and the mouth is at the confluence with Beaver Creek. Soils in West, Middle, East and mainstem Modoc Creek are very deep, well drained gravely loam to silty loam, formed from rhyolitic tuff and loess on mountain sides and foothills. Natural vegetation types for all of Modoc Creek are presumed to be drummond willow *(Salix drummondiana*), bebb willow (*Salix bebbiana*), and coyote willow (*Salix exigua)* .

Threemile Creek

West, East, and Middle Threemile Creeks are located in the upper middle section of the Beaver-Camas watershed where the dominant lithology is alluvial. Mainstem Threemile is located further south where dominant lithology transitions from alluvium to basalt.

Vegetation in upper East and Middle Threemile Creek is forested with the dominant vegetation types douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta).* At lower elevations, where the forestland ends, dominant vegetation transitions to a quaking aspen (*Populus tremuloides*)/red-osier dogwood (*cornus stolonifera*) community. Natural vegetation on West and Mainstem Treemile Creek consists of bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*).

West Camas Creek

West Camas Creek, located in the eastern half of the watershed, is a tributary of Camas Creek. West Camas Creek is dominated by stony to gravely loam, well drained soils originating from weathered rhyolite and closely related bedrock.

Vegetation in the watershed transitions from a douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)* community in the upper elevations to an aspen (*Populus* *tremuloides*)/red-osier dogwood (*cornus stolonifera*) community in mid elevations and finally transitioning to a bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)* community where West Camas and East Camas Creek converge to form Camas Creek.

East Camas Creek

Topography and vegetation on East Camas Creek are very similar to that of West Camas Creek. Vegetation consists of a conifer community in the upper elevations to a deciduous aspen community in the transition zone and a willow community in the lower elevations.

Target Selection

TMDL target selection addresses temperature and sediment values, which are discussed in the following:

Sediment

Target selection of sediment is dependent on existing narrative criteria of IDAPA 58.01.02.200.08.

Sediment targets for this subbasin are based on streambank erosion quantitative allocations in tons/mile/year. The reduction in streambank erosion prescribed in this TMDL is directly linked to the improvement of riparian vegetation density to armor streambanks thereby reducing lateral recession, trapping sediment. and reducing stream energy, which in turn reduces stream erosivity and instream sediment loading. It is assumed that by reducing chronic sediment, there will be a decrease in subsurface fine sediment that will ultimately improve the status of beneficial uses.

It is assumed that natural background sediment loading rates from bank erosion equate to 80% bank stability as described in Overton et al. (1995), where banks are expressed as a percentage of the total estimated bank length. Natural condition streambank stability potential is generally 80% or greater for Rosgen A, B, and C channel types in plutonic, volcanic, metamorphic, and sedimentary geology types. Therefore, an 80% bank stability target based on streambank erosion inventories shall be the target for sediment.

Unnatural streambed sediment size composition can directly impair spawning success, egg survival to emergence, rearing habitat, and fish escapement from stream. It is necessary to reduce the component of subsurface fine sediment less than 6.35 mm to below 28% of total subsurface sediment. This sediment particle size parameter should be considered as part of target monitoring to evaluate any significant shift in subsurface fine particle frequency distribution.

Temperature

It is known that solar load is affected by the amount of vegetation and other objects blocking direct sunlight from reaching the stream, and it is presumed that direct solar radiation is the most likely source of elevated stream temperatures in the Beaver-Camas subbasin. The target values for this TMDL are based on the percentage of effective shade at PNV. Natural stream width, channel type, and type of riparian community present are important factors to evaluate when determining the effective shade potential around a specific reach of stream. To determine the target values for streams in the Beaver-Camas subbasin, effective shade curves from the *Alvord Lake Subbasin Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP)* (Oregon DEQ 2003), *Potential Near-Stream land Cover in the Willamette Basin for Temperature Total Maximum Daily Loads* (Oregon DEQ 2004), *Walla Walla River Subbasin Stream Temperature Total Maximum Daily Load and Water Quality Management Plan* (Oregon DEQ 2004), and *South Fork Clearwater Total Maximum Daily* Loads (IDEQ 2004) were evaluated. These TMDLs had previously used vegetation community modeling to produce these shade curves. For Beaver Creek, Camas Creek, Dairy Creek, Modoc Creek, East Camas Creek, Threemile Creek, and West Camas Creek the most similar vegetation types were selected for shade target determinations. Because no two landscapes are exactly the same, shade targets were derived by taking an average of the various shade curves available (Tables 28-34). Alvord Lake vegetation is predominantly high desert/mountain valley shrub communities. The SF Clearwater VRU12/VRU16 plant communities were heavily dominated by grasses. Willamette Basin and Walla Walla River areas have a greater percentage of trees in their communities. The combination of all four of these community types balances out the variety of communities likely to be encountered in the Beaver/Camas subbasin.

Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type looses its ability to shade wider and wider streams. Because vegetative community and stream width determine the percent of expected shade, each of the streams were separated into different reaches based on varying stream width and vegetative community. The stream reach, type of vegetative community, reference shade curves, and the established shade target are shown in Tables 28-34.

As stated above, bankfull width is an essential parameter when utilizing effective shade curves for the determination of potential natural vegetation. Limited field measurements of bankfull width are available so, this parameter must be estimated from available information. Average values for bankfull channel width as a function of drainage area has been established for six regions, one of which is the Upper Salmon River (Rosgen 1996). Through the utilization of the Upper Salmon River regional curve, bankfull width was determined for each of the reaches listed in Tables 28-34. This was accomplished by calculating the upstream drainage area (DA) at the lower end of each of the stream reaches. Drainage area values were then utilized to determine average bankfull width for each stream reach. Derived bankfull width values were also compared to field measurements taken by BURP crews, showing that bankfull widths derived from the regional curve coincided with field measurements.

The utilization of the regional curve to determine bankfull width, rather than direct field measurements, serves to show that established target values were based on what expected (natural) bankfull width values are. As stated earlier, stream widening is a significant morphological change that takes place in riverine systems impaired by riparian grazing. Since morphological changes could lead to field measurements that misrepresent what undisturbed stream widths may be, bankfull width based on drainage area is a more accurate representation of what natural stream widths are.

Appendix J provides a more detailed delineation of each stream reach and the established target value.

Table 28. Beaver Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Modoc Creek to first canyon	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	7	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	52
			Walla Walla TMDL – Deciduous Zone (Figure 8)	85
			Willamette Basin TMDL – Qg1 (Appendix C)	70
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	25
				Target Average = 58
First Canyon (narrow and deep)	Canyon, bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*	7	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	48
			Walla Walla TMDL – Deciduous Zone (Figure 8)	78
			Willamette Basin TMDL – Qg1 (Appendix C)	66
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	21
Target Average = 53 however the steep walled canyon does not support vegetation so target set at **50** for maximum topographic shading				
Upper Canyon to below Spencer	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*	8	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	38
			Walla Walla TMDL – Deciduous Zone (Figure 8)	80
			Willamette Basin TMDL – Qg1 (Appendix C)	55
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	18
				Target Average = 48
Canyon Below Spencer	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	11	Same As First Canyon	
				Target Average =50
Shallow Canyon	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	14	Alvord Lake TMDL - Willow Community (Figure 2.40)	19
			Willamette Basin TMDL – Qg1 (Appendix C)	51
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	17
				Target Average = 29
Lower Beaver Below Canyon	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	15	Same as first canyon	
				Target Average = 50

Table 29. Camas Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper Camas Creek (eighteenmile	bebb willow (*Salix bebbiana*) and geyer willow (*Salix*	15	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	25
			Willamet Basin TMDL – Qg1 (Appendix C)	49

to first canyon)	*geyeriana)*		South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	11
				Target Average = 28
Canyon Areas	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	15	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	25
			Willamette Basin TMDL – Qg1 (Appendix C)	49
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	11
				Target = 28
Below Canyon to dry	dogwood, yellow willow (*Salix lutea*), and coyote willow (*Salix exigua)*	15	Alvord Lake TMDL - Willow Community (Figure 2.40)	17
			Willamette Basin TMDL – Qg1 (Appendix C)	49
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	11
				Target Average = 26

Table 30. Dairy Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper Dairy Creek (headwaters to forest boundary)	douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*	2	Alvord Lake TMDL - Black Cottonwood-Pacific Willow Community (Figure 2.31)	85
			Walla Walla TMDL – Deciduous-Conifer Zone (Figure 8)	90
			Willamette Basin TMDL – Qalf (Appendix C)	85
			South Fork Clear Water TMDL – VRU 3 Stream breaklands, grand fir and Douglas Fir (Figure F-20)	92
				Target Average = 88
Lower Dairy Creek (forest boundary to mouth)	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	3	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	60
			Willamette Basin TMDL – Qg1 (Appendix C)	70
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	30
				Target Average = 53

Table 31. Modoc Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
East, West, Middle Modoc Creek and upper Mainstem Modoc Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	3	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	75
			Walla Walla TMDL – Deciduous Zone (Figure 8)	90
			Willamette Basin TMDL – Qg1 (Appendix C)	80
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	50
				Target Average = 74
Lower Modoc creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana*	5	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	60
			Walla Walla TMDL – Deciduous Zone (Figure 8)	85
			Willamette Basin TMDL – Qg1 (Appendix C)	70

			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	30
				Target Average = 61

Table 32. Threemile Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper East Threemile Creek and Upper Middle Threemile Creek	douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*	3	Alvord Lake TMDL - Black Cottonwood-Pacific Willow Community (Figure 2.31)	80
			Walla Walla TMDL – Deciduous-Conifer Zone (Figure 8)	90
			Willamette Basin TMDL – Qalf (Appendix C)	76
			South Fork Clear Water TMDL – VRU 3 Stream breaklands, grand fir and Douglas Fir (Figure F-20)	86
				Target Average = 83
Lower East Threemile Creek and Middle Threemile Creek	Quaking aspen (*Populus tremuloides*)/red-osier dogwood (*cornus stolonifera*)	4	Alvord Lake TMDL - Co-dominant Aspen-Willow C ommunity (Figure 2.38)	80
			Walla Walla TMDL – Deciduous Zone (Figure 8)	85
			Willamette Basin TMDL – Qg1 (Appendix C)	75
				Target Average = 80
West Threemile Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	3	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	75
			Willamette Basin TMDL – Qg1 (Appendix C)	80
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	50
				Target Average = 70
Mainstem Threemile Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	5	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	60
			Willamette Basin TMDL – Qg1 (Appendix C)	70
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	30
				Target Average = 53

Table 33. East Camas Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper East Camas Creek	douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*	4	Alvord Lake TMDL - Black Cottonwood-Pacific Willow Community (Figure 2.31)	79
			Walla Walla TMDL – Deciduous-Conifer Zone (Figure 8)	87
			Willamette Basin TMDL – Qalf (Appendix C)	72
			South Fork Clear Water TMDL – VRU 3 Stream breaklands, grand fir and Douglas Fir (Figure F-20)	86
				Target Average = 81
Lower East Camas Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	8	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	45
			Willamette Basin TMDL – Qg1 (Appendix C)	67
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	21
				Target Average = 44

Table 34. West Camas Creek Established Shade Target Values

Location	Vegetative Community	Average Stream Width (m)	Reference Shade Curve	Percent Target Shade
Upper West Camas Creek	douglas fir (*Psuedotsuga menziesii)* and lodgepole pine (*Pinus contorta)*	4	Alvord Lake TMDL - Black Cottonwood-Pacific Willow Community (Figure 2.31)	79
			Walla Walla TMDL – Deciduous-Conifer Zone (Figure 8)	87
			Willamette Basin TMDL – Qalf (Appendix C)	72
			South Fork Clear Water TMDL – VRU 3 Stream breaklands, grand fir and Douglas Fir (Figure F-20)	86
				Target Average = 81
Middle West Camas Creek	(*Populus tremuloides*)/red-osier dogwood (*cornus stolonifera*)	8	Alvord Lake TMDL - Co-dominant Aspen-Willow Community (Figure 2.38)	59
			Walla Walla TMDL – Deciduous Zone (Figure 8)	79
			Willamette Basin TMDL – Qg1 (Appendix C)	67
				Average = 68
Lower West Camas Creek	bebb willow (*Salix bebbiana*) and geyer willow (*Salix geyeriana)*	9	Alvord Lake TMDL - Co-dominant Willow Alder (Figure 2.39)	60
			Willamette Basin TMDL – Qg1 (Appendix C)	70
			South Fork Clear Water TMDL – VRU 12/VRU 16 Stream breaklands, bunchgrass and shrubland (Figure F-20)	30
				Target Average = 40

Target values are established in consideration of Idaho’s existing numeric criteria for salmonid spawning and cold water aquatic life. It is expected that riparian shading at or around the target value will provide stream temperatures where beneficial uses are supported. It is expected that if potential natural vegetation is achieved and stream temperatures exceed the criteria, beneficial uses will be supported at system potential. This temperature TMDL is based on meeting potential natural riparian vegetation conditions in the watershed. Shade targets were developed with the idea that once shade levels are met, streams will achieve temperatures consistent with those achievable under natural conditions. Once natural conditions are known, natural background provisions of Idaho water quality standards (IDAPA 58.01.02.200.09) will apply and the applicable water quality criteria will not apply.

Monitoring Points

Monitoring points for this TMDL address subsurface sediment, streambank stability, riparian shading, and temperature monitoring, all of which are discussed in the following.

Subsurface Sediment

Subsurface sediment substrate monitoring points shall occur in habitat determined suitable for salmonid spawning within listed stream segments using the McNeil core sediment sampling method. The amount of habitat suitable for salmonid spawning will increase after the implementation of management practices identified to reduce fine sediment.

Streambank Stability

Streambank erosion inventories/assessments shall occur on sediment-impaired streams to evaluate overall bank stability.

Temperature Monitoring

Stream temperatures will be monitored with an instream temperature logger in previously established monitoring sites to maintain consistency.

Riparian Shade

Riparian shade shall be monitored with a solar pathfinder in temperature impaired streams to determine percentage of effective shading and evaluate long term trends in stream riparian conditions.

5.2 Load Capacity

A load capacity is “the greatest loading a waterbody can receive without violating water quality standards” [40 CFR §130.2]. This must be at a level to meet “...water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge...” (Clean Water Act § 303(d)(C)). Likely sources of uncertainty include lack of knowledge of assimilative capacity, uncertain relation of selected target(s) to beneficial use(s), and variability in target measurement.

Load capacities are defined for sediment and temperature as discussed in the following.

Sediment

The load capacity for sediment from streambank erosion shall be based on assumed natural streambank stabilities of greater than or equal to 80% (Overton et al 1995). Because it is presumed that beneficial uses were or would be supported at natural background sediment loading rates, the loading capacity lies somewhere between the current loading level and sediment loading from natural streambank erosion.

- Natural background loading rates are not necessarily the loading capacities. An adaptive management approach will be used to provide reductions in sediment loading based on best management practice (BMP) usage coupled with data collection and monitoring to determine the loading point at which beneficial uses are supported.

- The estimated capacity is directly related to the improvement of riparian vegetation density and structure as well as maintenance of roads and stream crossings. Increased vegetative cover provides a protective covering of streambanks, reduces lateral recession, traps sediment, and reduces erosive energy of the stream.

There is a large degree of uncertainty as to the percentage of sediment loading available before beneficial uses are no longer supported. Because it is presumed that beneficial uses were or would be supported at natural background sediment loading rates, the loading capacity lies somewhere between the current loading level and sediment loading from natural erosion.

Temperature

The loading capacity for a stream under PNV is essentially the solar loading allowed under the shade targets specified for the reaches within the stream. These loads are determined by multiplying the solar load to a flat plate collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e. the fraction open or 1 – shade fraction). In other words, if a shade target is 60% (or 0.6), then the solar load hitting the stream under the target is 40% (or 0.4) of the load hitting the flat plate collector.

Solar load data was obtained from flat plate collectors from the closest National Renewable Energy Laboratory (NREL) weather station in Pocatello, ID. The solar loads used in this TMDL are spring/summer averages, thus we used an average load for the seven month period from April through October. These months coincide with time of year that stream temperatures are increasing and when deciduous vegetation is in leaf. Table 29 and Appendix J show the PNV shade targets (identified at Target or Potential Shade) and their corresponding potential summer load (in KWh/m^2/day) that serve as the loading capacities for the streams.

5.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

Sediment

Estimated existing pollutant loads for streambank sediment are based on streambank erosion inventories conducted by the DEQ in 2004. The current sediment loading-rate for Camas Creek in the Beaver-Camas Subbasin is quantitatively estimated in tons/mile/year, as shown in Table 35.

Temperature

Estimated existing pollutant loads for solar radiation are based on field measurements with the Solar Pathfinder and aerial photo interpretations of percent canopy cover (Figures 62-68). The percent daily total solar radiation was converted to solar load (kWh/m^2/day) by multiplying the open fraction times the average summer (April-October) solar radiation measure by a flat plate collector at the National Renewable Energy Lab (NREL) in Pocatello, Idaho. Table 36 shows the calculated estimated load for temperature TMDL streams in the subbasin. Appendix J lists the estimated existing canopy cover and estimated existing load for stream segments.

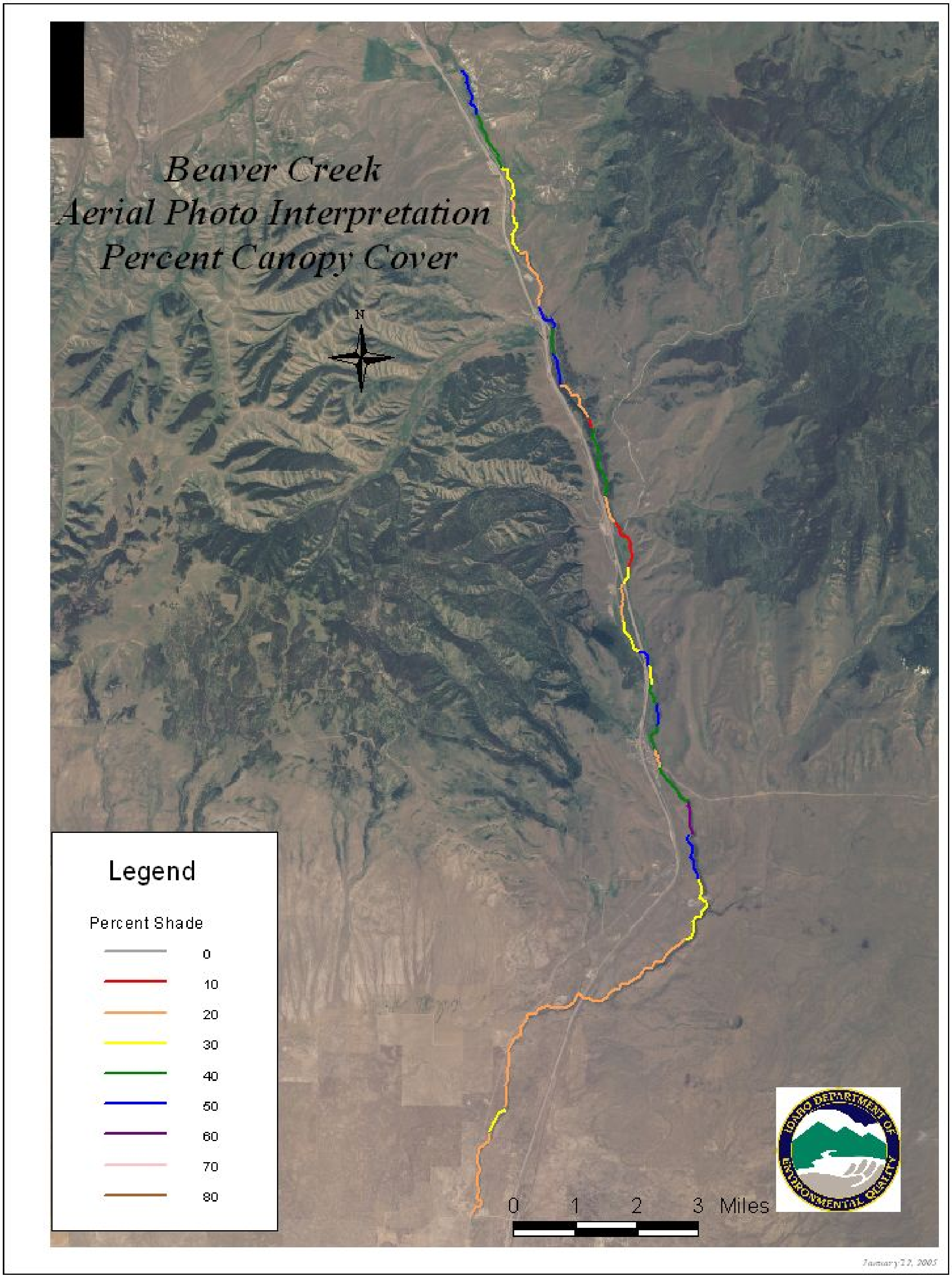

Figure 62. Estimated Percent Canopy Cover for Beaver Creek

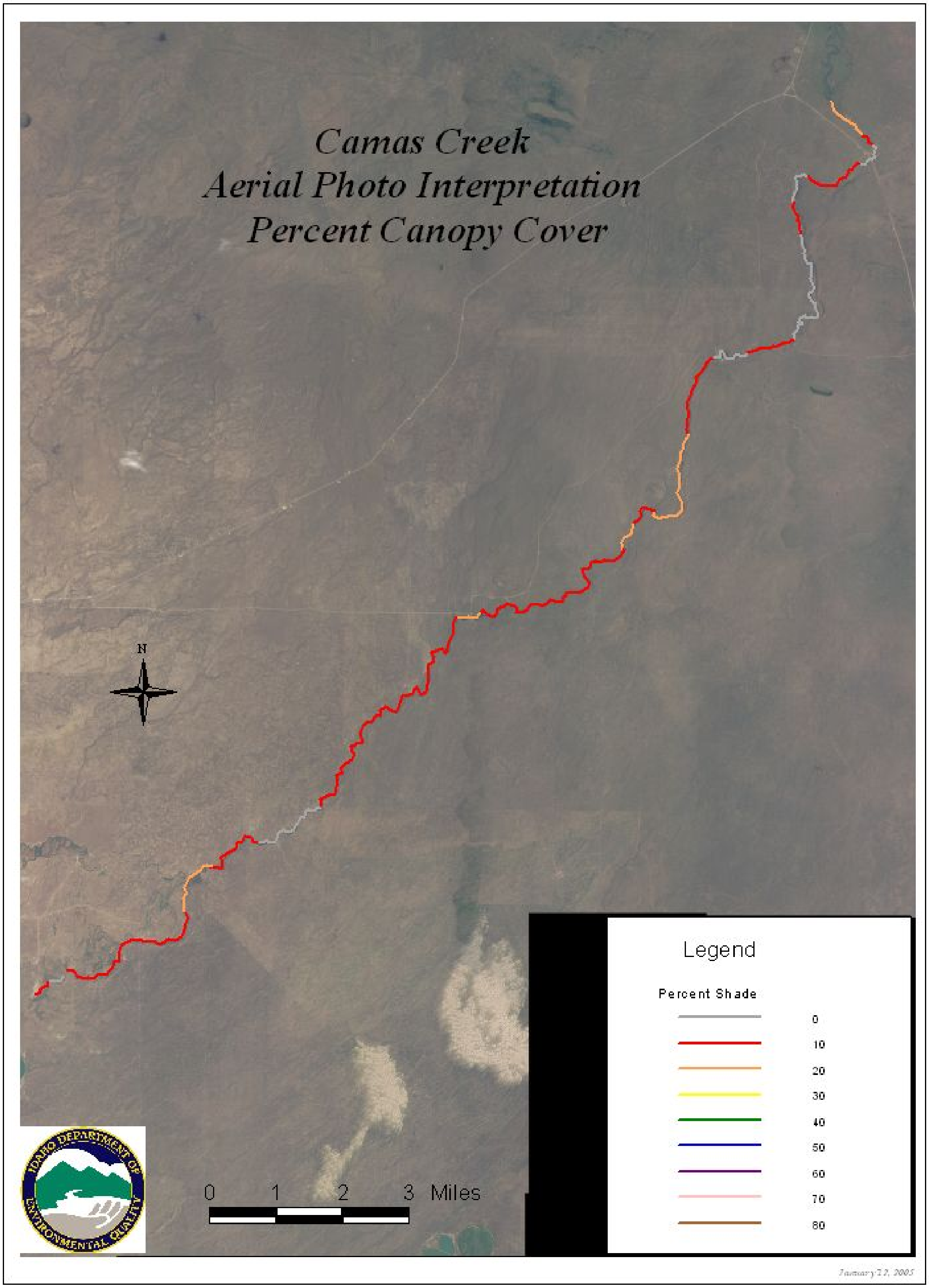

Figure 63. Estimated Percent Canopy Cover for Camas Creek

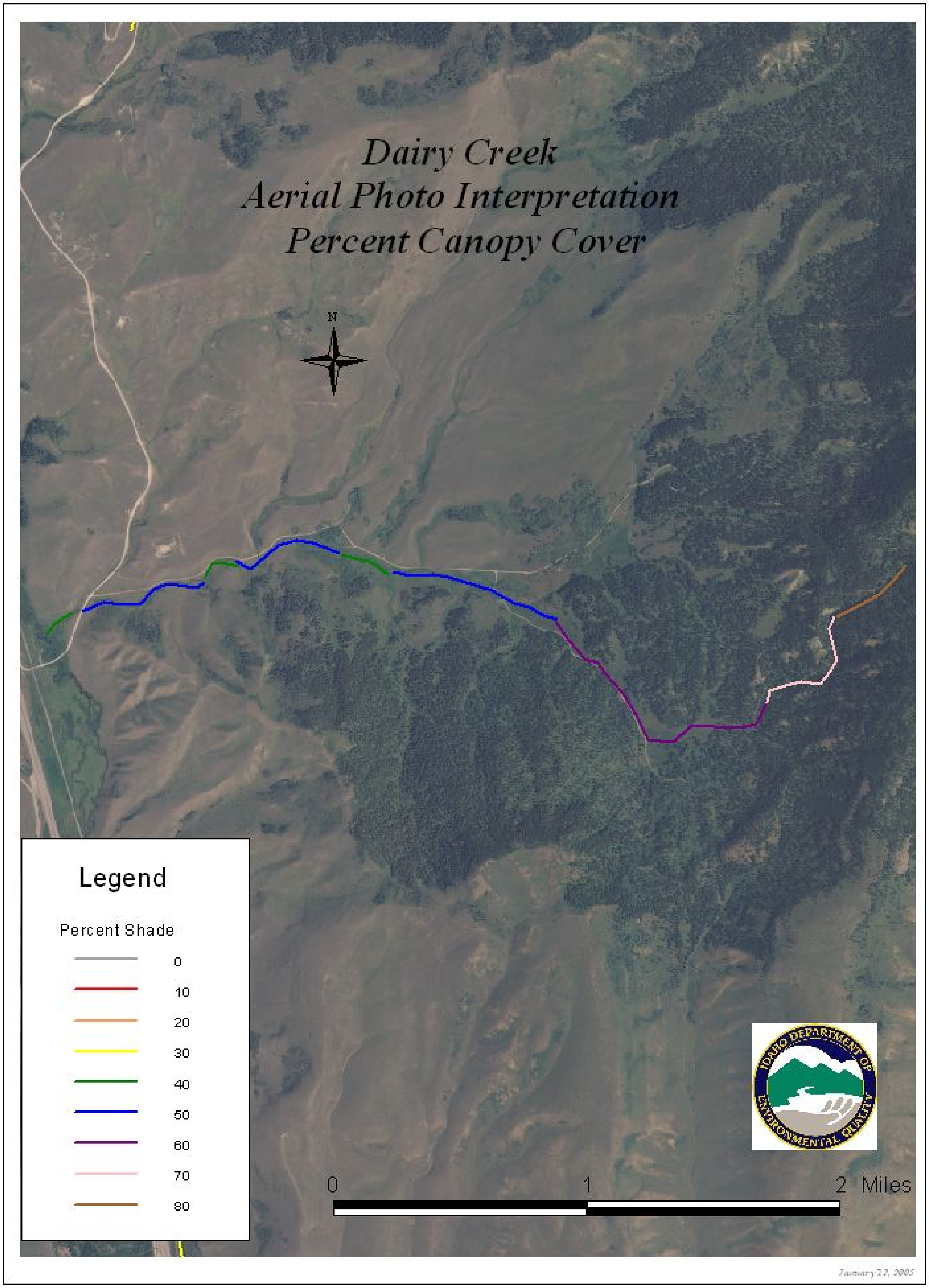

Figure 64. Estimated Percent Canopy Cover for Dairy Creek

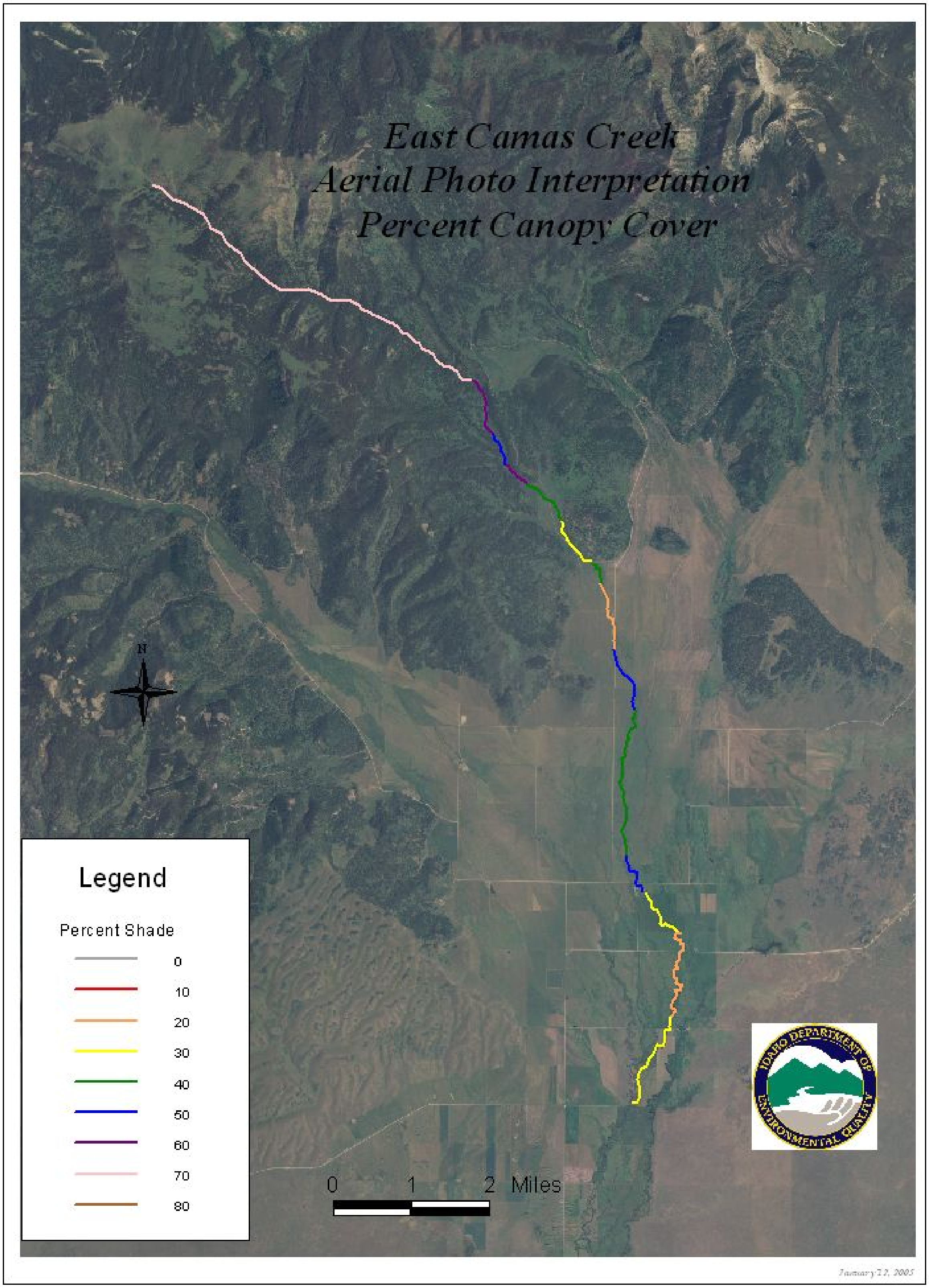

Figure 65. Estimated Percent Canopy Cover for East Camas Creek

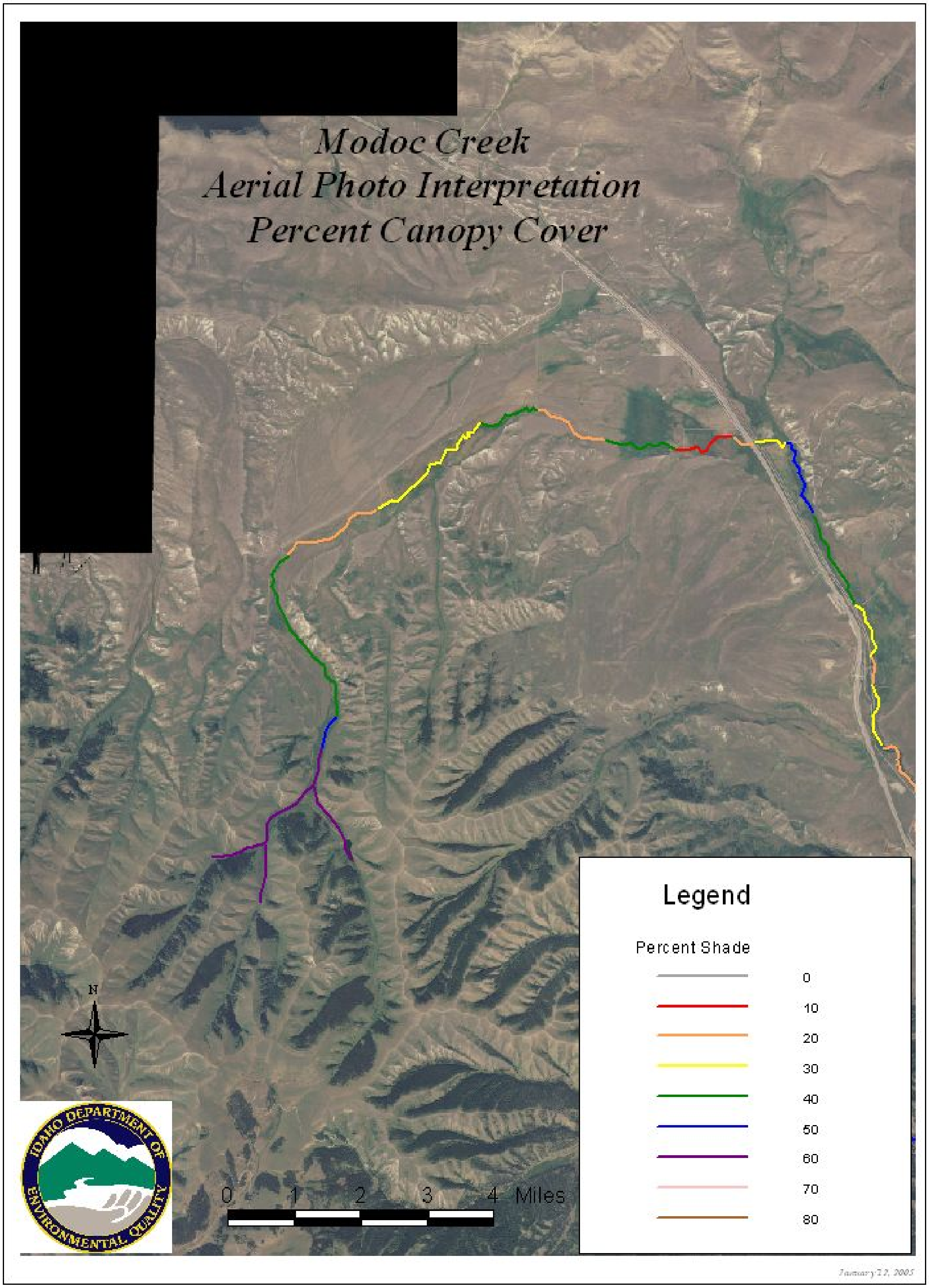

Figure 66. Estimated Percent Canopy Cover for Modoc Creek

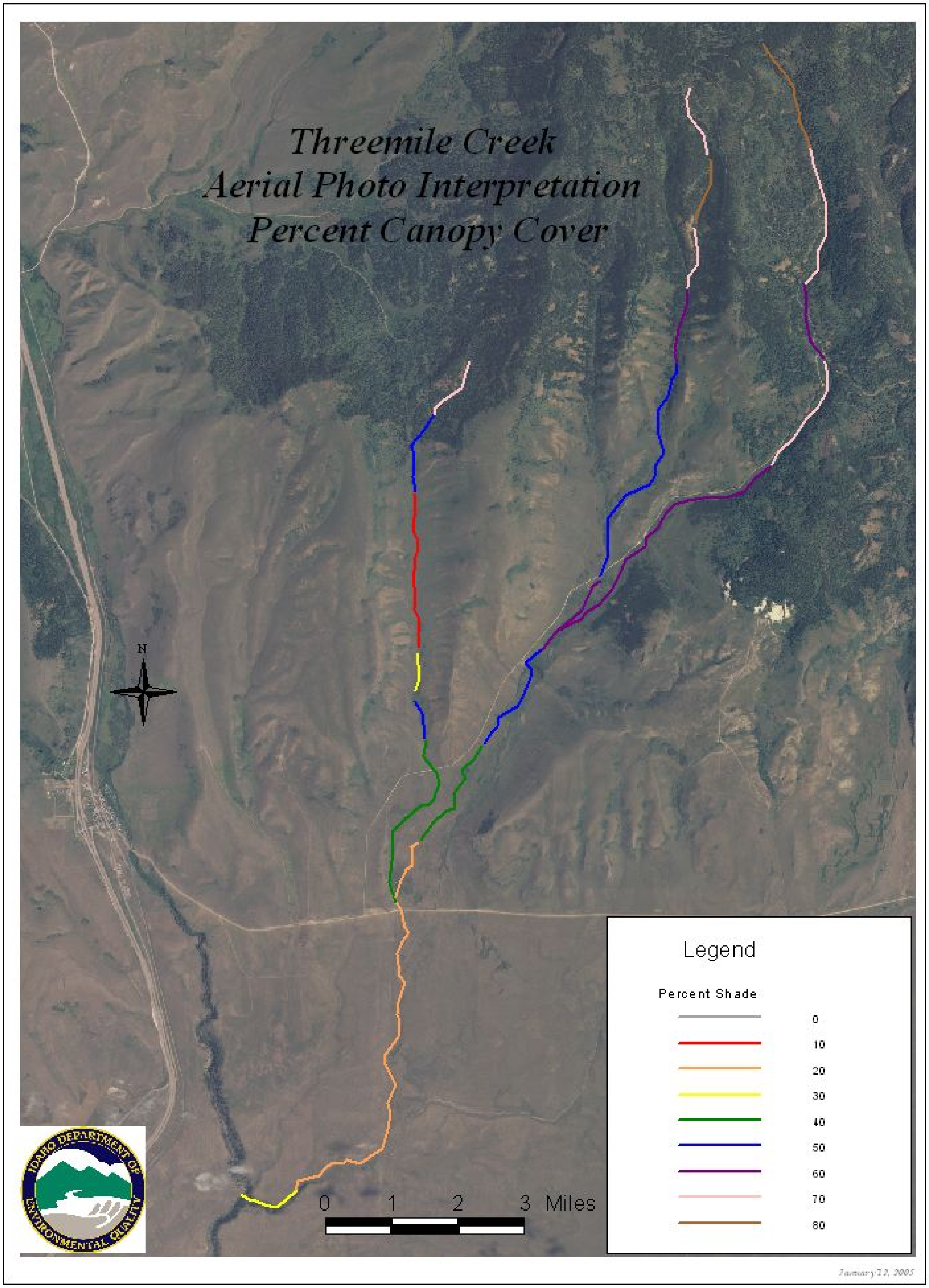

Figure 67. Estimated Percent Canopy Cover for Threemile Creek

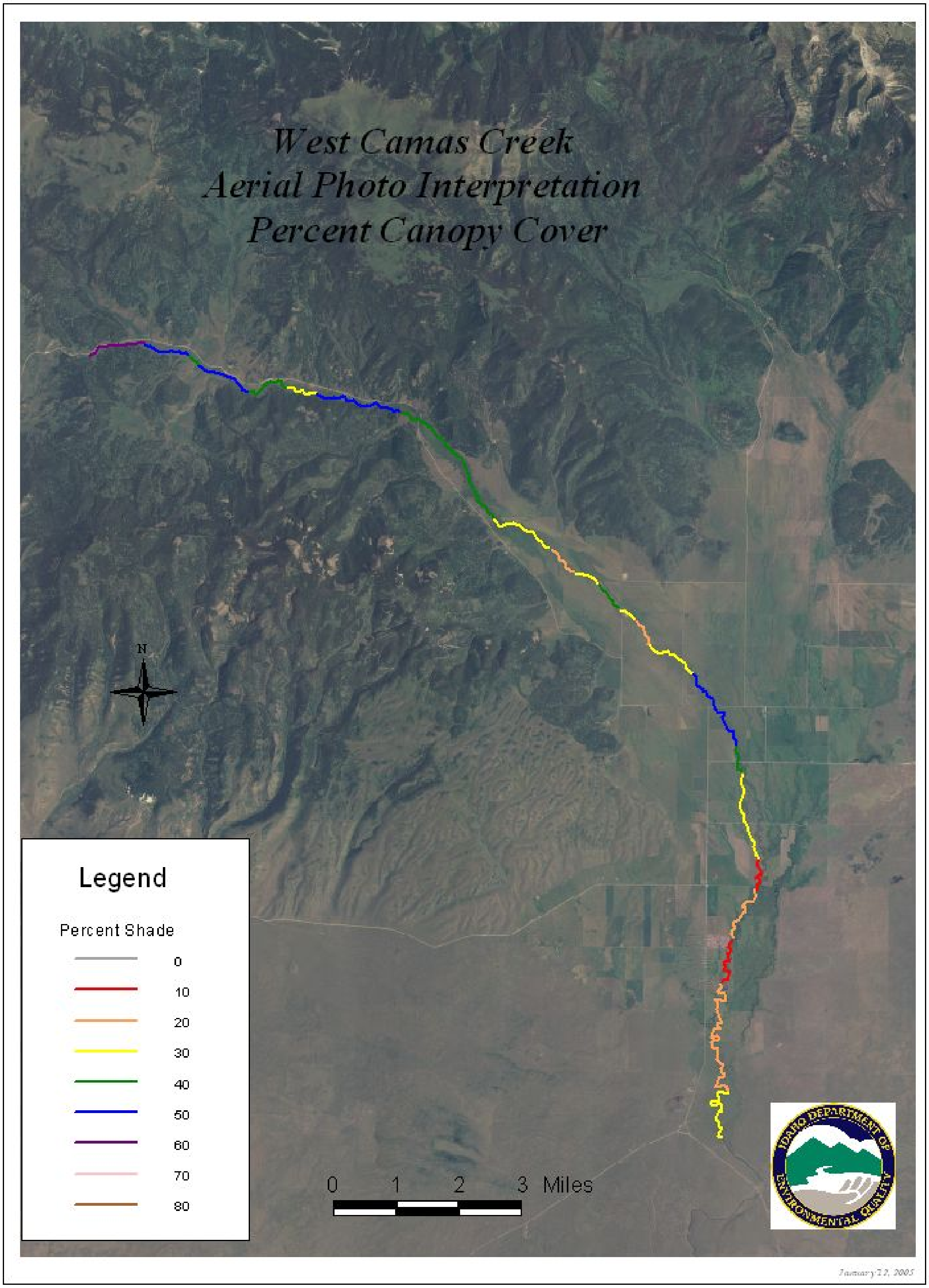

Figure 68. Estimated Percent Canopy Cover for West Camas Creek

5.4 Load Allocation

Wasteload Allocations

Because there are no point source discharges in the Beaver-Camas Subbasin, there are no wasteload allocations (WLA) in the TMDL.

Load Allocations

For the Beaver-Camas Subbasin, sediment and temperature load allocations have been developed, as shown on Tables 35 and 36. The load allocation is the amount of loading capacity allocated to a given source without exceeding water quality criteria.

Sediment

The sediment load allocation for Camas Creek was developed from streambank erosion inventories conducted by the DEQ in accordance with methods outlined in the section 2.4 of this document.

Temperature

The temperature load allocations for Beaver, Camas, Dairy, East Camas, Modoc, Threemile, and West Camas Creeks were developed in accordance with methodologies discussed in section 2.3 of this document. The difference between the current solar load (kWh/m^2/day) and the load capacity (target) is the load allocation (kWh/m^2/day).

Table 35.   Sediment load allocations for Beaver-Camas Subbasin.

Stream	CURRENT LOAD Existing Erosion Rate (t/mi/yr)	LOAD CAPACITY Erosion Rate (t/mi/yr)	LOAD ALLOCATION Total Erosion Rate Reduction (t/mi/yr)	Total Erosion % Reduction to Meet Load Capacity
Camas Creek	1482	406	-1076	73

Table 36. Temperature load allocations for Beaver-Camas Subbasin

Stream	CURRENT LOAD Existing Summer Load ($kWh/m^2/day$)	LOAD CAPACITY Potential Summer Load ($kWh/m^2/day$)	LOAD ALLOCATION Load Capacity minus Current Load ($kWh/m^2/day$)	% Reduction to Meet Load Capacity
Beaver Creek	4.08	3.34	-0.74	18
Camas Creek	5.56	4.47	-1.09	20
Dairy Creek	3.08	2.41	-0.46	15
East Camas Creek	3.56	2.79	-0.76	21
Modoc Creek	3.78	2.11	-1.66	44
Threemile Creek	2.85	1.74	-1.11	39
West Camas Creek	3.92	2.36	-1.36	35

Margin of Safety

The margin of safety (MOS) factored into sediment load allocations is implicit. The MOS includes the conservative assumptions used to develop existing sediment loads. Conservative assumptions made as part of the sediment loading analysis include the following:
Desired bank erosion rates are representative of assumed natural background conditions.
Water quality targets for percent depth fines are consistent with values measured and are set by local land management agencies based on established literature values, incorporating an adequate level of fry survival to provide for stable salmonid production.

The margin of safety in this TMDL is implicit in the development of the potential effective shade. Effective shade is based on the hypothesis that the stream will experience a complete potential natural vegetal community along its borders all of the time. In reality, plant communities vary considerably with time as a result of natural disturbance (fire) and differential growth rate of plant species. Natural shade conditions are considered in this TMDL to be equivalent to natural temperature conditions, and that is the coolest the stream can achieve.

Seasonal Variation

Seasonal variability was built into this TMDL by developing sediment loads using annual average rates determined from empirical characteristics that developed over time within the influence of runoff events and peak and base flow conditions. Streambank erosion inventories take into account that most bank recession occurs during peak flow events, when the banks are saturated. The estimated annual average sediment delivery is a function of bankfull discharge. It is assumed that the accumulation of sediment within dry channels is continuous until flow resumes and the accumulated sediment is transported and deposited.

Temperature criteria are applied to different time periods due to differences in life histories of target species and different regulatory conventions. The target species in this analysis has been spawning and rearing salmonids. Considering the fact that potential natural vegetation estimations include deciduous species as well as conifers, the effective shade calculation targets the summer time period when the canopy should be at its greatest extent.

Climatic conditions vary from year to year, however, the target effective shade should be consistent from year. The majority of plant species considered are either long lived or receive their watering needs from the stream itself. The meadow is one area that may have its canopy cover more affected by drought conditions than other habitat types.

Background

Natural background loading rates are assumed to be the natural sediment loading capacity of 80% or greater streambank stability and 28% or less subsurface fine sediment. Therefore, natural background is accounted for in the load capacity.

Reserve

If uses are supported at load levels different than those specified in the TMDL, then there may be some reserve capacity to adjust the TMDL loads.

Construction Storm Water and TMDL Waste Load Allocations

Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past, storm water was treated as a non-point source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development) that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

Storm Water Pollution Prevention Plan (SWPPP)

In order to obtain the Construction General Permit (CGP), operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically, and maintain the best management practices (BMPs) through the life of the project.

Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed, DEQ now incorporates a gross waste load allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate Best Management Practices.

Typically, there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site specific standards that are applicable.

Remaining Available Load

Since the entire load allocation is given to current nonpoint sources, assuming those sources can achieve the desired reductions, there is no remaining available load for future allocation.

5.5 Implementation Strategies

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Several designated land management agencies are involved where watershed implementation is concerned. The largest portion of the watershed, with perennial water, consists of private and forest service land. The Idaho Association of Soil Conservation Districts (IASCD) and the USFS will provide implementation strategies for riparian management for the areas that fall under their realm of jurisdiction. A much smaller portion of the watershed is made up of BLM and state land, both of which are responsible for developing an implementation plan.

Time Frame

The expected time frame for attaining the water quality standard and restoring beneficial use is a function of management intensity, climate, ecological potential, and natural variability of environmental conditions. If implementation of best management practices is embraced enthusiastically, some improvements may be seen in as little as several years. Even with aggressive implementation, however, some natural processes required for satisfying the requirements of this TMDL may not be seen for many years. The deleterious effects of historic land management practices have accrued over many years and recovery of natural systems may take longer than administrative needs allow for.

Approach

It is anticipated that by improving riparian management practices, overall riparian zone recovery will precipitate streambank stabilization, reduce sedimentation, increase canopy cover, and lower stream temperatures, all of which will precipitate overall stream habitat improvements. Such improvements will contribute to an overall improvement in stream morphology and habitat, shifting stream health towards beneficial use attainment.

Responsible Parties

The IASCD, IDL, BLM, and USFS are the identified as the federal and state entities that will be involved in or responsible for implementing the TMDL.

Monitoring Strategy

It is presumed that instream temperatures will continue to be monitored with temperature loggers to evaluate improvements or declines in temperature regimes. Streambank erosion inventories are intended for rapid assessment, but will allow for the evaluation of streambank condition in the absence of more rigorous evaluation. Stream subsurface fine sediment should continue to be assessed through McNeil sediment core sampling at established intervals to identify trends toward meeting sediment targets. Beneficial Use Reconnaissance Program monitoring will continue to be conducted by DEQ and should also provide insight regarding steam conditions.

5.6 Conclusions

As shown by Table 37, the primary water quality concern in the watershed is elevated stream temperatures. To address this concern, eight temperature TMDLs have been written to address this non-point source pollutant. Elevated temperatures in the basin are attributed to riparian vegetation disturbance and the unique hydrologic features that occur in the Beaver-Camas Subbasin. The complex system of gaining reaches in the upper, mountainous regions, and loosing reaches in the lower basalt dominated regions contribute to divergent stream characteristics between the upper and lower sections of the basin. As the subbasin assessment shows, natural flow losses coupled with irrigation water removal from the stream make it difficult to attain beneficial use support in select streams. Where flow limitations do not completely impede beneficial use support, a temperature TMDL was developed for the streams with documented exceedances in the temperature criteria.

Beaver, Dairy, East Camas, Modoc, Threemile, and West Camas Creeks support active beaver complexes which may increase stream temperatures by reducing stream flows and holding water back in stagnant pools where thermal loading to the stream is higher.

The only sediment TMDL in the basin was developed for Camas Creek. Riparian grazing is the principal land use around Camas Creek. Stream characteristics of Camas Creek alternate between basalt canyons and depositional openings between canyons. The areas where the basal canyons do not armor the banks experience the highest grazing pressure and grazing impacts; hence, streambank erosion results in sedimentation.

Table 37. Summary of assessment outcomes.

Water Body Segment	Assessment unit of 17040214	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Beaver Creek* (Spencer to Dubois)	SK015_05	Flow	No	List below Exit 172 and de-list above Exit 172	Flow Altered (natural)
		Habitat	No	None	EPA Policy
		Nutrients	No	De-list	No Exceedances Documented
		Sediment	No	De-list	No Impacts Documented
		Temperature	Yes	None	Exceedances Documented
Beaver Creek* (Dubois to Camas Creek)	SK003_05 SK014_05	Flow	No	None	Flow Altered (natural and anthropogenic)
		Habitat	No	None	EPA Policy
		Nutrients	No	None	Flow Altered (natural and anthropogenic)
		Sediment	No	None	Flow Altered (natural and anthropogenic)
		Temperature	No	None	Flow Altered (natural and anthropogenic)
Beaver Creek (Headwaters to Spencer)	SK021_02 SK021_03 SK020_03 SK018_04 SK024_02	Temperature	Yes	None	Exceedances Documented
Camas Creek* (Spring Creek to Hwy 91)	SK002_05	Flow	No	List below T9N, R37E, Section 16 and de-list above	EPA Policy
		Habitat	No	None	EPA Policy
		Nutrients	No	De-list	No Exceedances Documented
		Sediment	Yes	None	Impacts Documented
		Temperature	Yes	None	Impacts Documented
Camas Creek* (Hwy 91 to Mud Lake)	SK001_06	Flow	No	None	Flow Altered (natural and anthropogenic)
		Nutrients	No	De-list	Flow Altered (natural and anthropogenic)
		Sediment	No	De-list	Flow Altered (natural and anthropogenic)
Cow Creek* (Headwaters to Thunder Gulch)	SK018_04	Unknown	No	List	Flow Altered (natural)
Dairy Creek (Headwaters to Mouth)	SK018_02	Temperature	Yes	None	Exceedances Documented
East Camas Creek (Headwaters to Mouth)	SK011_03 SK010_02 SK010_03	Temperature	Yes	None	Exceedances Documented
Modoc Creek (Headwaters to Mouth)	SK021_02	Temperature	Yes	None	Exceedances Documented
Threemile Creek (Headwaters to Mouth)	SK017_02 SK017_03	Temperature	Yes	None	Exceedances Documented
West Camas Creek (Headwaters to Mouth)	SK012_03 SK013_02 SK013_03	Temperature	Yes	None	Exceedances Documented